Reducing Waste in a Converting Operation

Introduction
According to the principles of Lean Manufacturing there are 7 potential areas of waste in your plant. These include: Transport, Inventory, Motion, Waiting, Over-processing, Overproduction and Defects. While the numbers vary across industries and companies, the amount of waste can exceed 20% of a plant’s output. All waste is directly translated into lost profit! The waste caused by defects is particularly costly. On top of this, the cost of waste caused by throwing away good product just to ensure defects are removed is exponentially higher.

This paper discusses a unique method of measuring and tracking defect waste during the converting process. It also discusses a system that automates the defect removal process while preserving good product. The result of implementation is that you will stop sending bad product to your good customers and stop sending good product to the waste bin. Waste will be reduced and profits will be restored.

Waste caused by Defects
Let’s face it—defects happen! Of the 7 potential areas of waste mentioned above, defects usually cause the most lost profits. Defects take on many forms and originate from multiple sources. Being alerted to defects as they are occurring and quickly eliminating their source will reduce the number of defects produced. For the hard to eliminate defects that make it through your process, knowing their exact position in the roll is critical for downstream removal. In a perfect world, all defects are detected automatically and their cross-web and down-web positions are known and recorded. “Table A” below shows a chart indicating a general defect type and a common automatic detection method.

Table A: Defects and Detection Methods

<table>
<thead>
<tr>
<th>Defect Type</th>
<th>Detection Method</th>
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<tbody>
<tr>
<td>All discrete defects such as holes and spots. All visible surface variations such as streaks and lumps.</td>
<td>Full Web Inspection System</td>
</tr>
<tr>
<td>Print defects and pattern defects.</td>
<td>Print Inspection System</td>
</tr>
<tr>
<td>Thickness, color and coat weight variations.</td>
<td>Beta Gauge or other quality scanner</td>
</tr>
<tr>
<td>Process upsets and changes such as make ready, grade changes and raw material run-outs.</td>
<td>Output monitoring of mill PLC or DCS</td>
</tr>
<tr>
<td>Operator induced defects such as sample taking, roll cleaning and manual machine adjustments.</td>
<td>Operator report via push button or log</td>
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Defect Tracking and Removal

RYECO Incorporated of Marietta, Georgia has recently introduced a unique system that significantly reduces the waste associated with defects. RYECO’s Rollsync System automatically collects all available defect information listed in Table A. The data is captured electronically and is instantly tagged with down-web start and stop positions and if applicable, cross-web position. As the roll is being processed, the entire length of the roll is marked with position codes (unique evenly spaced binary values). The codes start at zero and continue at pre-set intervals until the roll is complete. The result is that the roll itself becomes a continuous “tape measure.”

During downstream processing (e.g., Slitting) the defect data is synchronized to the actual position in the roll by reading the codes from the moving web. The downstream operator is able to see each approaching defect and determine the best corrective action required. More importantly, RYECO’s Rollsync System can automatically stop the process precisely at the start of the defective area and indicate to the operator how much product to remove. Only defective product is removed and no time is wasted searching for the defect.

Waste Tracking

A second and equally important benefit of Rollsync is the ability to track all waste created during the converting process. If we think of the “tape measure” analogy, it is easy to understand how this works. If a 20 inch tape measure starts at, say 15.5 inches, it is easy to determine that 4.5 inches were removed from the end (See Figure 1 below). Also if the tape is unrolled and stopped at the 3.2 Inch mark, it can be deduced that there is 2.8 inches remaining on the roll. Taking this example further, if the numbers on the tape measure jump from 8 to 11 and they are .5 inches apart, you can also conclude that 2.5 inches are missing from the middle of the tape. Rollsync works in exactly the same manner using the position codes to determine the amount of product removed during converting.

Figure 1. The “Tape Measure” Illustration
Three general types of waste are generated during converting:

1. Slabbing - Removing layers of product off the top of a finished roll.
2. Defect Removal – Removing defective sections of product in the middle of a roll.
3. Left on Core – Leaving some product on the core to allow for easy rethreading.

Your operation may or may not have all three and it is important to note that the second type may have multiple occurrences in a roll.

As the roll is converted in a downstream process, the position codes are monitored in real time for three things:

1. Any difference between the upstream finished length of the start of roll position downstream. (Slabbing Waste)
2. Any skips in numeric codes, including defect removal at the downstream machine. (Defect Removal Waste)
3. The position when the roll stopped being processed. This is determined at the last code read and the lineal distance traveled from that code. (Left on Core Waste)

It is important to note that even though the codes may be spaced every 50 feet or so, the system uses an encoder to fill in the space between codes, giving accuracy as fine as one encoder pulse. Position tracking accuracies of inches is possible using this technique.

**Figure 2. Rollsync Block Diagram**

**How Rollsync Works**

The Rollsync System consists of three main components: A Code Marking System on the upstream asset; a Code Reading System on the downstream asset; a PC based server residing somewhere in the plant. There are two main operator interfaces: A screen near the Downstream asset for viewing and selecting defects for removal and a PC based terminal (the server) for higher level Waste Tracking analysis, Roll Historian and Yield Management tasks.

**Upstream**

The Code Marking System receives a “start of roll” signal and begins placing binary codes at pre-set intervals along the edge of the web. Zero is usually the first code value printed and the values always increment by one, no matter the spacing interval. A typical spacing interval is 50 or 100 feet or meters.
The Code Marking System receives digital inputs from the various automatic detection systems and the mill DSC (Distributed Control System) or PLC (Programmable Logic Controller). Each input is assigned a defect type and a start and stop position by the Code Marker and passed electronically along with roll ID (via Ethernet) to the server PC. If the event is upstream or downstream from the point of code marking, an offset is also determined. The server stores all defect information in an SQL type database.

Figure 3. Printing Position Codes on the Moving Web.

At the end of the roll a file is created which contains the Roll Identification (Roll ID) and any pertinent information about the roll. This includes length of the finished roll, time, date and any other information the plant desires. The file points to all pertinent defect data in the SQL database. If a Full Web Inspection System creates its own defect maps, these data files are also merged into the database. The WIS and the RollsSync System must be synchronized to the same encoder signal.

**Downstream**

When a roll of product arrives at the downstream asset for processing it is first scanned for Roll ID. Once the roll is loaded onto the machine for processing the code reader waits for the first code. Length prior to finding the first code is tracked and added to the total roll. When position is established, a list of defects requiring action is displayed to the operator. A default action can be assigned automatically by the server, for example: “stop for all large holes.” The operator may be given permission to override the default or to add other defects to the automatic stopping queue.

The system can handle either fully or partially processed rolls. If a roll is not completely processed the remaining data is saved and recalled the next time the roll is loaded. As a roll is processed a post-processing file is created that contains information about which defects were removed and exactly how much waste was created. This information can be analyzed across several rolls, months or plants. A quality history of each roll is saved for future quality verification.
Conclusion

RYECO’s Rollsync System is a valuable tool for reducing waste in a converting plant. With the ability to auto-stop the system precisely and quickly at the location of a defect you will save time and good product. Also, having a tool that accurately measures and tracks every inch of waste is critical for any waste reduction program. Now you can sell only good product to your best customers and throw away only bad product.